ORIGINAL COMMUNICATION

Gross Anatomy Examination Performances in Relation to Medical Students' Knowledge of Classical Latin and Greek

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The ability of medical students to acquire anatomical and medical terminologies could be influenced by their knowledge of classical Greek and Latin. In a previous study (Stephens and Moxham 2016, Clin. Anat. 29:696at.), it was reported that, while newly recruited medical students have a very favorable attitude toward the need to understand these classical languages, final year students see no benefit. In this study, we tested the hypothesis that, regardless of attitude, students in the initial stages of their medical education perform better at both summative and formative anatomy examinations if they have prior knowledge of Greek and Latin. First year medical students at Cardiff University who had been involved in the previous study concerning attitudes toward the relevance of the classical languages to medical education were evaluated in terms of their examination results in anatomy. Two hundred and twenty-seven students responded to a questionnaire (83% of the class) that categorized students into their linguistic knowledge and skills and their performances in formative and summative examinations were analyzed. For medical students with prior knowledge of classical Greek and Latin performed better in both summative and formative anatomy examinations. The results are therefore consistent with our hypothesis. Clin. Anat. 00:000–000, 2018.

Key words: medicine; anatomy; terminology; medical education; classical Latin and Greek

INTRODUCTION

Despite anatomy providing fundamental information, skills, and attitudes for all medical specialities (Turney et al., 2001; Patel and Moxham, 2006; Turney, 2007; Sugand et al., 2010; Papa and Vaccarezza, 2013), the importance of the anatomical sciences in the medical curriculum has been much debated, particularly since there has been a trend to reducing significantly what is perceived as the "weight of factual information" within the medical curriculum ((e.g., Association of Medical Colleges (AAMC) and General Medical Council (GMC)). Indeed, there have been significant reductions in the number of teaching hours devoted to gross anatomy. Within the United States, for example, Drake et al. (2002, 2009, 2014) recorded that the hours devoted to the teaching of gross anatomy had declined from just under 780 hours per annum in 1931 (Reid, 1931) to about 340 hours in 1955 (Berry et al., 1956) to 147 hours in 2014. Perhaps one of the reasons for the decline in the importance of the anatomical sciences relates to the discipline being described as "banausic," "archaic," "didactic," "traditional," "overtly factual," and "unable to adapt to modern educational methods" (Turney et al., 2001). In our view, we would expect the marked reductions in time allocated to the

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Received 26 January 2018; Accepted 30 January 2018

Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.23056

anatomical sciences to be accompanied by reductions in understanding of the anatomical terminologies with knock-on effects on students' abilities to learn, and retain, newly introduced terminologies (Kulkarni, 2014; Singh et al., 2015; Stephens and Moxham, 2016).

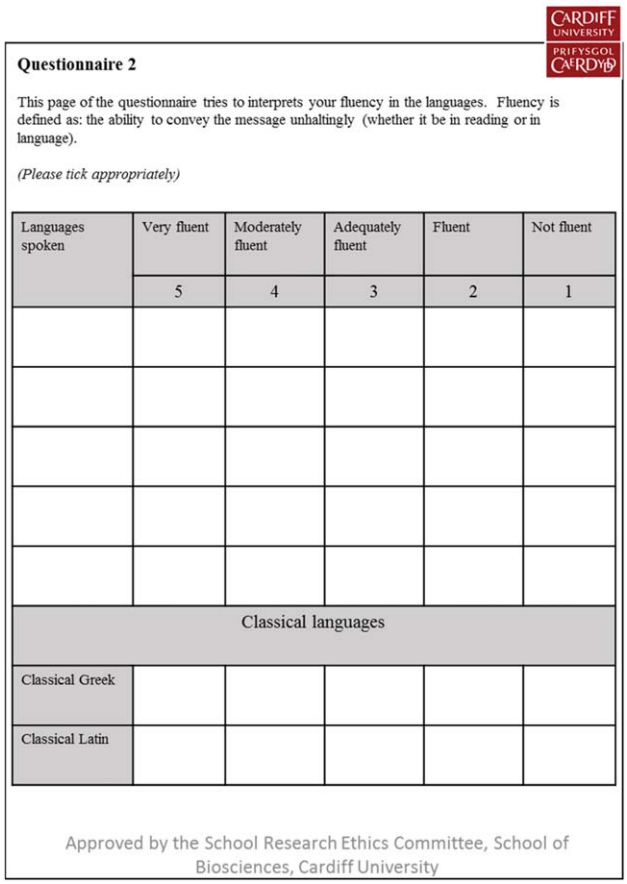
It is conceivable that medical students find new anatomical terminologies challenging to learn since they are derived from classical Greek and Latin, languages that nowadays students have little knowledge of before entering medical school (Terminologia Anatomica 1998, Federative International Programme on Anatomical Terminologies 2009, 2013). In a previous study (Stephens and Moxham, 2016), we reported however that, despite having little or no classical Greek or Latin, the students have a markedly positive attitude toward the importance of understanding these classical languages for their medical education (although this was not a view shared by the final year medical students). In the present study, we follow up this earlier report by investigating whether performance in anatomy assessments are related to knowledge of classical Greek or Latin. Our hypothesis is that, regardless of attitude, students in the initial stages of their medical education perform better at both summative and formative anatomy examinations if they have prior knowledge of Greek and Latin. To test this hypothesis medical students at Cardiff University were provided with questionnaires to ascertain their linguistic proficiency while anonymous examination performance data were provided by the Medical Assessment Office at Cardiff.

METHODS

Following ethical approval from the Research Ethics Committee at the Cardiff School of Biosciences, questionnaires were distributed amongst the first medical students at Cardiff University. The questionnaire consisted of a series of matrices that allowed the students to assess aspects of their personality, fluency, and proficiency in modern and classical languages. In addition, it enabled evaluation of their linguistic skills for reading and listening to modern and classical languages. Figure 1 provides an example of a matrix within the questionnaire. The students were given an information sheet and a consent form along with the questionnaire and their participation was voluntary. The students had time to ask any questions to the principal investigator before completing the questionnaire.

The formative and summative marks of the respondents were collected by the principal investigator from the Medical Assessment Office at Cardiff. These data were anonymous but could be related to the responses of the questionnaire by a unique code whose identity was known only to the Medical Assessment Office.

To assess the reliability and validity of the questionnaire, a group of 20 students who were not involved in the present study completed the questionnaire twice, the second time three weeks after initially responding to the questionnaire.



Questionnaire 2

This page of the questionnaire tries to interprets your fluency in the languages. Fluency is defined as: the ability to convey the message unhaltingly (whether it be in reading or in language).

(Please tick appropriately)

Languages spoken	Very fluent	Moderately fluent	Adequately fluent	Fluent	Not fluent
	5	4	3	2	1
Classical languages					
Classical Greek					
Classical Latin					

Approved by the School Research Ethics Committee, School of Biosciences, Cardiff University

Fig. 1. Shows an example of a matrix within the questionnaire. [Color figure can be viewed at wileyonlinelibrary.com]

Data were entered on Excel spreadsheets and analyzed using Minitab 18 statistical software. Anderson-Darling normality tests, Whitney-Mann *U* tests, Levene's tests, ANOVA tests, *t*-tests and Cronbach's alpha tests were employed.

RESULTS

Two hundred and twenty-seven students responded to the questionnaire. The student cohort consisted of two hundred and seventy-five students and therefore the response rate is 83%. The respondents were categorized into seven groups. The categories are as shown in Table 1.

Cronbach's alpha tests were used to assess the reliability of the questionnaire. These tests resulted in the calculation of an alpha coefficient of 0.87, an α coefficient between 0.65 and 0.8 showing that a questionnaire is reliable and valid.

Figure 2 provides a histogram comparing the average marks attained by the various categories of first year medical students during their formative and summative anatomy examinations. The histogram indicates that the students who had a prior knowledge

TABLE 1. Shows the Different Groups, Categories, and Number of Respondents

Groups	Categories	Number of students in each categories
Group A	Students who had prior knowledge of Greek and/or Latin from school (Pre GCSE) (age less than 14 years)	13
Group B	Students who have studied Greek and/or Latin in GCSE (aged 14–16 years)	21
Group C	Students who are very fluent in English and other European language	22
Group D	Students who are very fluent in English and also other non-European languages	12
Group E	Students who are fluent in English only	24
Group F	Students who are moderately fluent in English with high fluency in other non-European languages	11
Group G	Students who are very fluent in English with moderate fluency in other European and non-European languages	124

of classical languages (Groups A and B) performed better than their peers.

To substantiate the findings from the histogram, and to check if the data were normally distributed, Anderson-Darlington normality tests were performed (Figs. 3 and 4). It was established that both the summative ($P = 0.0002$) and formative ($P = 0.0003$) examination data were normally distributed. To assess statistical significance of the summative and formative examinations, ANOVA single factor tests were conducted. Figure 2 suggests that students performed better in all groups in formative examination than summative anatomy examinations. Whitney-Mann *U* tests were conducted on formative and summative data to evaluate the hypothesis that the difference in the two sets of medians were statistically significant. As the *Z* score was -3.06661 with $P < 0.002$ the results of the test were significant. Thus, the difference in two medians is statistically significant, meaning that the probability of the difference being due to chance is $<0.002\%$.

To ascertain whether there is statistical significance between different groups of students, *t*-tests were undertaken. To choose the appropriate *t* test, it was necessary to establish if the variants were equal or unequal. Levene's tests were performed on the data and it was found that the variants were unequal as the intervals did not overlap and the standard deviations were significantly different (Figure 5). Multi *t*-tests for unequal variants were therefore performed

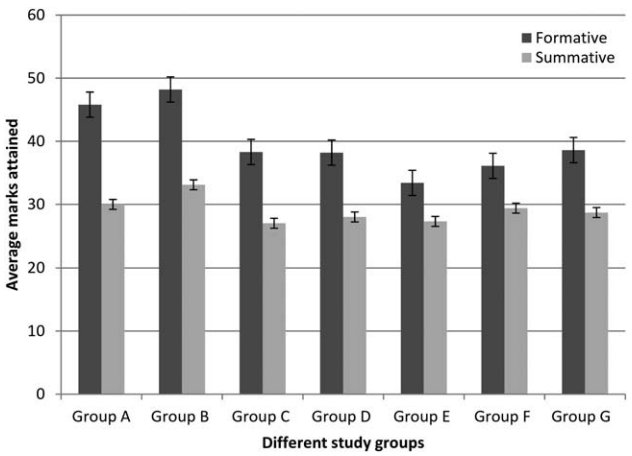


Fig. 2. Histogram showing the comparative performance of first year medical students during their formative and summative anatomy examinations. For a description of Groups A to G, see Table 1. Students who had a prior knowledge of classical languages (Groups A and B) performed better than their peers.

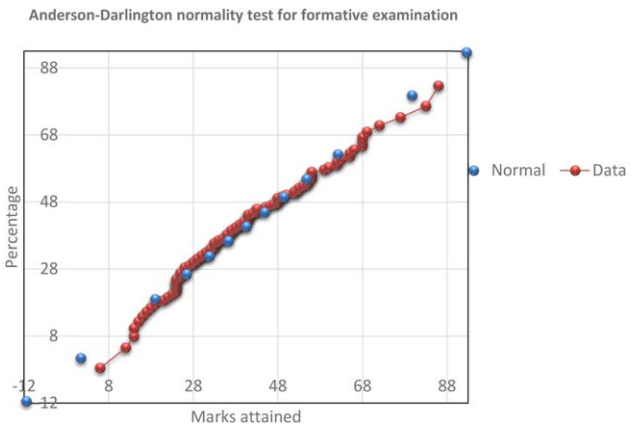


Fig. 3. Graph showing the Anderson-Darlington normality test for formative anatomy examination for first year medical students at Cardiff. The graph shows that all sets of data were not normally distributed. [Color figure can be viewed at wileyonlinelibrary.com]

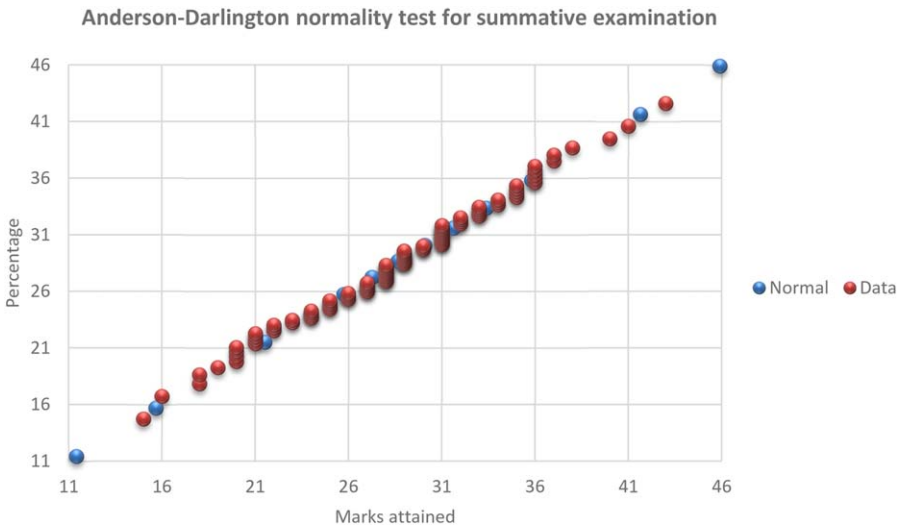


Fig. 4. +Graph showing the Anderson-Darlington normality test for summative anatomy examination for first year medical students at Cardiff. The graph shows that all sets of data were not normally distributed. [Color figure can be viewed at wileyonlinelibrary.com]

between groups of formative and summative examination data. It was established that Groups A and B students (those who had prior GCSE knowledge in classical languages) were statistically significantly different from other groups ($P = 0.002$). It was therefore concluded that students who had a prior knowledge of classical languages such as Greek and Latin performed better that their peers in both formative and summative examinations.

DISCUSSION

While the students who have had prior knowledge of Greek and Latin at school performed better in both formative and summative anatomy examinations, our findings can only apply to the early stages of their medical training. To evaluate whether this advantage persists during later stages of the medical course, it will be necessary to conduct a longitudinal study, especially since our previous work (Stephens and Moxham, 2016) suggests that final year medical students have less positive attitudes toward the importance of understanding classical languages. We maintain nevertheless, the notion that, if there is an advantage for some students, all other students should be offered opportunities to develop similar skills at an early stage.

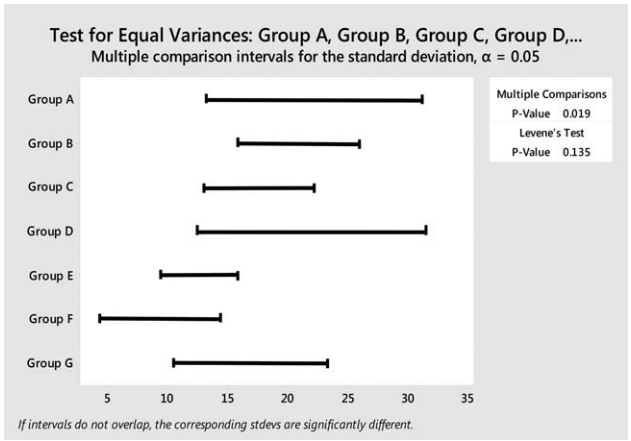


Fig. 5. Graph showing the results of the Levene's test conducted on groups A-G. As the intervals do not overlap, the standard deviations are accepted to be significantly different.

It could be argued that medical students who have had Greek and Latin in their preuniversity education were not advantaged specifically by their knowledge of these classical languages but have benefitted from being recipients of a more liberal preuniversity education or have personalities more fitting to scholarly activities. The section of the questionnaire where the students evaluated their personalities is pertinent with regard to this matter. It was found that 75% of students who were multilingual (having knowledge of more than one language, whether classical or contemporary) classified themselves as being curious, organized, outgoing, and friendly. Conversely, 85% of monolingual students graded themselves as being cautious, easy going, reserved and detached. Thus, personality self-assessment suggests that a more scholarly background is significant and this needs further investigation using established instruments for personality assessment (e.g., Big Five Inventory test (BFI) John and Srivastava, 1999).

Further analysis of Groups A and B (highest scoring groups for anatomy assessments) showed that, for the 13 students, in Group A, 10 were educated in private/independent schools while three were from

grammar schools. In Group B, 18 of the 21 students were from private/independent schools while two attended grammar schools. This finding appears to diverge from a report of the Higher Education Funding Council for England (HEFCE) in 2013/14 that claimed that state school students perform better, at degree level than their privately educated peers (HEFCE report, 2015). They stated that 82% of state school graduates achieved first or upper second-class degrees compared to 73% of graduates from private schools. The report suggested that state school pupils perform better at university because such schools are less well-resourced compared to private schools so that a student from state school is able to grasp better the equal opportunities provided by university. Of course, other explanations are possible, including relationship between social status and incentivisation to perform well at university, more effective teaching at private schools that mask true academic potential, or private school pupil believing that their social status goes beyond the need for excellence at university (Zanini and Rodeiro, 2016). Regardless of the reasons our results are consistent with our hypothesis that prior knowledge of classical languages aids examination performance.

It has been estimated that 50% of modern English vocabulary is derived from Latin and 20% from Greek. Furthermore, according to Banay (1948), classical Greek and Latin have shaped the development of modern European languages, it being estimated that nearly three-fourths of medical terminology is derived from the classical languages. One can only speculate the reasons for such developments but all significance must be the fact that the Greeks were the founders of rational medicine during the 5th century B.C.E (Banay, 1948; Moxham and Plaisant, 2014; Moxham and Sprumont, 2016). The Hippocratic School and Galen formulated the terminologies which dominated medicine (including anatomy) up to the beginning of the 18th century B.C.E. It can be argued, therefore, that having a prior knowledge of Greek and Latin can improve anatomical understanding and also one's vocabulary in general. Marković (2007) has reported that, with a sound knowledge of Latin, one can better understand the basis of grammar and be able to apply that knowledge to other languages. Thus, it is conceivable that students with prior knowledge of Greek or Latin tend to develop linguistic and cognitive skills more quickly, thus helping them understand and learn anatomy as a new language. It can also be suggested that students with prior knowledge in a subject or language, being classified as having "higher expertise levels," possess more concepts for easily integrating and relating additional information (Hailikari et al., 2008). If so, this might be a further reason why students with prior knowledge of Greek or Latin performed better in their anatomy examinations.

In addition to our findings describing possible advantages of having knowledge of classical Greek and Latin, we also have data that compares the performance of medical students in formative and summative anatomy examinations regardless of their linguistic skills. We report that all types of students performed better at formative assessments that summative assessments.

It has been reported that students perform better in formative examinations as they are presented with explicit goals and outcomes (Dunn and Mulvenon, 2009). Formative assessments also help students identify their strengths and weaknesses and target areas that require further work (Chappuis and Stiggins, 2002). As these examinations are "low-steaks," the student is under less pressure to perform and the results help following self-reflection.

Newble and Jaeger (1983) documented the effects of assessment on the learning behavior and devised the adage "assessment drives learning." Subsequently, this adage has been widely used as fundamental rule in medical education such that, assessment has been regarded as an "educational tool" by educationalist in general (Krupat and Dienstag, 2009; Wood, 2009). Indeed, there has been much discussion about whether students should adopt deep learning strategies in higher education or whether, being "examination conscious," they remain as strategic learners (Chin and Brown, 2000). According to Hudson and Bristow (2006) and Roediger and Karpicke (2006), the types of examinations (and their consequences) can alter the learning behavior of a student. In this context, students tend to learn more effectively for summative examinations due to the consequence of potential failure, while the incentive for formative examinations (feedback generating) is little. For these reasons, it is often assumed that students perform better at summative examinations that formative examinations. Our data show a converse relationship. We suggests that this relates to the fact that the formative assessments given to Cardiff medical students relate primarily to their anatomical knowledge whereas the summative assessments at Cardiff are integrated examinations covering a great variety of subject .We conclude that there is risk in integrated examinations of students not studying anatomy as well as they would should only anatomical knowledge be assessed.

RECOMMENDATIONS

As we have presented evidence that prior knowledge of Greek and Latin influences examination results, it would be sound practise to introduce lessons/tutorials that help the students understand, and apply, these languages for the understanding of anatomy. Perhaps such tuition might only be required by those who have not learnt classical languages before entering medical school. We need of course, to be aware that students must feel that there is a real benefit to any instruction that one might give them to improve their knowledge of Greek and Latin. Kalyuga and Renkl (2010) and Ormrod (2012) report that the principal factor affecting learning is the learner's prior knowledge of a subject. It is thought that, while learning, students make networks between newly acquired facts and prior knowledge (called retrieval pathways), seek structure within the material, explore principles and assimilate facts across domains. To increase the

amount of retrieval pathways, the given context should be relevant to the content to be learned (Bergman et al., 2015). With these retrieval pathways, the student is able to increase the amount of knowledge through elaboration (i.e., the learner is able to generate meaningful connections between prior and new contents [Schmidt, 1993; Kalyuga, 2009]). Koens et al. (2003) suggest that relevance and familiarity to the subject plays a positive influence and contributes to increased acquisition and recall of knowledge. In our previous study (Stephens and Moxham, 2016), we reported that first year medical students have a positive attitude toward understanding classical languages for their medical education and therefore they would be open to having some extra tuition in these languages. That final year students however are not convinced of the need to have understanding of classical languages we surmise that "familiarity has bred contempt"!

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